Local manufacturing for health in Africa in the time of Covid-19: experience and lessons for policy

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Local manufacturing for health in Africa in the time of Covid-19: experience and lessons for policy

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Cover image: Sino-Ethiop capsule manufacturing plant in Ethiopia.

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Acronyms

ABLE	Association of Biotechnology Led Enterprises
AI	artificial intelligence
AMA	African Medicines Agency
ANDI	African Network for Drugs and Diagnostics Innovation
API	active pharmaceutical ingredients
ARV	antiretroviral
AUDA	African Union's Development Agency
CII	Confederation of Indian Industry
DEGRP	Development and Economic Growth Research Programme
FAPMA	Federation of African Pharmaceutical Manufacturers Associations
FICCI	Federation of Indian Chambers of Commerce and Industry
GMP	Good Manufacturing Practice
IDMA	Indian Drug Manufacturers Association
IP	intellectual property
IPA	Indian Pharmaceutical Association
ISRO	Indian Space Research Organisation
MNC	multinational corporation
MRH	Medicines Regulatory Harmonisation
NEPAD	New Partnership for Africa's Development
OPPI	Organisation of Pharmaceutical Producers of India
PCR	polymerase chain reaction
PPE	personal protective equipment
PPP	public-private partnership
RNA	ribonucleic acid
S&T	science and technology
TRIPS	Trade-Related Aspects of Intellectual Property Rights
UNECA	United Nations Economic Commission for Africa
VTM	viral transport medium
WTO	World Trade Organization

Summary

In Africa and across the globe, the Covid-19 pandemic has demonstrated the fragility of manufacturing supply chains, particularly in relation to essential commodities for healthcare. It has forced a global recognition of local manufacturing and supply chains' centrality to local health security. This report summarises findings from a webinar, hosted on 28 October 2020, which brought African manufacturers in health-related industries together with engaged academics in India and Africa, and other professionals working on the regulation, distribution and industrial support in African countries. The webinar aimed to capture the immediate experience of manufacturing under Covid-19 conditions in Africa and India and to draw lessons for policy.

The central argument is that broad-based industrial development is critical for local health security in Africa; this is the post-Covid-19 medium-term challenge. As the pandemic unfolded, African manufacturers experienced the collapse of input supply chains, with vertiginous increases in imported input prices alongside escalating freight costs. Buyers' payments slowed, exacerbating the financial squeeze on manufacturers. Lack of local input suppliers, especially in active pharmaceutical ingredients (APIs), medical grade fabric and plastics, and high-quality packaging, alongside weak local testing and accreditation capability, constrained local manufacturers' outputs just as demand escalated. Nevertheless, the webinar identified an impressive range of scaling up and product innovation by African manufacturers to meet local pandemic needs.

Core lessons

Four core lessons, were identified. First, broadening and deepening the African industrial base is essential to *reduce the concentration risk* that arises from reliance on a small number of largely external suppliers of essential items. More local suppliers, new industrial collaborations and stronger backward linkages in the health industries are all required. Industry associations can act as brokers or intermediary institutions, facilitating knowledge renewal and promoting linkages between critical sectors.

Second, this industrial deepening requires *better collaborative capabilities* among multiple actors such as the private sector and governments, including through public-private partnerships (PPPs). Countries that reacted fast to the pandemic crisis have displayed capacity to collaborate, co-learn and co-solve old and new problems across industry, academia and government: this momentum must be sustained.

Third, this in turn requires *strengthening and re-thinking the role of the public health system in stimulating local industrial development*, through innovative procurement, assured markets for local manufacturers, and shaping technological upgrading. Local health systems can and must develop more agency, power and leverage in shaping local industrial and technological development.

Finally, *centres of excellence* can provide the infrastructure that is needed in African regions to support quality improvement and technological capability upgrading in emerging industrial clusters. This includes enhancing scarce skills, providing patient funding at scale, market development, innovation and supply chain strengthening.

Indian experience during the pandemic confirms the importance of a broad industrial base, sustained local engineering knowledge and opportunities for rapid adaptation and collaboration across industrial sectors. Negative lessons included the relative neglect in India pre-Covid-19 of service sectors such as cold-chain storage and delivery. Indian experience also identifies the importance of active contestation for policy effectiveness, through challenging engagement in policy debate by diverse stakeholders. Finally, India-Africa collaboration remains relatively weak: African market integration and policy shifts could improve the incentives for Indian investment in Africa in the medium term.

Covid-19 has been a wake-up call for the importance of local manufacturing for health in Africa, but what will it take to stay awake? Participants identified priorities for sustained investment in institutions to support industrial development at national and regional levels. These included stronger testing-regulation-accreditation processes for new and upgraded outputs, as well as better industrial finance to support innovation and technological development. Policy capabilities for active problem-solving could be strengthened by effective contestation and policy learning, including an active role for industrial associations. The report concludes by identifying further research needed to support integration of industrial, institutional and health policies for managing public health security risks in African countries.

1. Introduction

The impact of the Covid-19 pandemic in Africa has exacerbated health and socioeconomic inequalities, severely stressed national health systems, and significantly slowed down economic growth attained by sub-Saharan African countries in the past two decades. It has opened up debates exploring the tough recovery roads ahead, against the backdrop of the economic impact of pandemic lockdowns and depleted local pharmaceutical capabilities, but also in the light of some positive experiences of adaptation and local response.

These debates have echoed, and pulled to centre stage, the importance and fragility of local manufacturing suppliers to healthcare. As import-dependent African countries saw their international supply chains collapse, local manufacturers attempted to fill the gaps with varying degrees of success. Supply chains for essential commodities including medicines and vaccines, diagnostics, medical devices, personal protective equipment (PPE), swabs and hand sanitisers, among others, are no longer seen as just a technical matter of buying available inputs for a health system; globally they are now understood as central matters of health security. The importance of local capabilities, and the proximity of manufacturers to their health systems, has crystallised in a moment of great need.

A webinar organised in October 2020, facilitated by the authors of this report and hosted by ODI, aimed to capture some of this immediate experience of manufacturing under Covid-19 conditions in both Africa and India, and to draw lessons for policy. It brought together by invitation African manufacturers in the health-related industries and other professional participants working in the fields of regulation of health supplies, in distribution and in industrial support in African countries. Researchers engaged with the pandemic manufacturing response in India and in Africa were also invited.

Beforehand, 17 participants provided notes beforehand of the key points they wished to make, and then took part in a detailed discussion over three sessions. The Appendix to the report contains a partial list of participants: those happy to have their name included. The report has been sent for comment by all participants before publication. We are most grateful to all participants for their time, contributions, further comments, and commitment to addressing these complex realities.

Participants argued that the distinctive local concerns under Covid-19 conditions should be a loud wake-up call for African and other low- and middle-income countries to pull together the policies and instruments for supporting local industry, science and health in order to strengthen the security of supply of pharmaceuticals, vaccines, medical devices and other essential requirements for local healthcare. The central argument that emerged is that a broad-based industrial structure is critical for local health security – and hence global health security during pandemics. Furthermore, building a sustainable local health-industrial complex also contributes strongly to broad-based industrialisation in Africa.

This report captures some of the contributions and debates from the webinar, identifying lessons for the future. The next section outlines the reported experiences of African manufacturers. The core of the report is then an overview of the issues and themes emerging from the webinar debate on African manufacturing for health in the time of Covid-19, as a contribution to policy thinking and research. This is followed by a section reflecting on learning from the distinctive Indian experience and the scope for greater India-Africa collaboration. The final section reflects on the understandings of 'policy' that help support the effective and sustainable development of the African health-industrial complex. This is critical for local health security and has cumulative effects on global health security.

2. African manufacturers' pandemic experience

> *'For local manufacturers generally it's been a negative experience.'*
> (East African pharmaceutical manufacturer)
>
> *'Great what people have been able to do – highlights innovation of African companies to use what they've got and go for it.'*
> (West African textile manufacturer)

Both the above statements were widely endorsed in the webinar by those with direct experience of manufacturing in sub-Saharan Africa during the Covid-19 pandemic. The immediate negative impact of the crisis was immense across health-related manufacturing on the subcontinent. However, the pandemic also opened spaces for local manufacturers to show what they could achieve under pressure to support fragile health systems in a process of rapid scarcity-induced innovation.

2.1 Negative pressures

> *'Africa found itself inevitably at the back of the queue for all product supplies.'*
> (Southern African pharmaceutical manufacturer)

Many African stakeholders have been warning for years[1] that in a global pandemic, African needs would be sidelined in a global nationalistic rush to buy up essential supplies. In 2020, it happened. As the pandemic began, not only did imports of essential items dry up, but supplies of key inputs to local manufacturing were also cut off by competition from large-scale buyers with deeper pockets, while prices of inputs shot up (Box 1).

That immediate supply chain collapse through competition was exacerbated by the disappearance of flights and escalating freight costs for remaining cargo capacity. The sharp financial squeeze on firms was aggravated by other sources of financial loss: private debtors and governments were slower to pay, while remaining input suppliers still required pre-payment.

In a final irony, established firms such as a West African textile manufacturer exporting medical scrubs to the US found both export markets and local production were threatened because of a loss of essential inputs, including imports of meltblown fabric for face masks from India and indeed South Africa. China produces about 40% of the world's meltblown fabric, which is an essential component of masks: prices are reported to have increased as much as 20-fold with the advent of the Covid-19 pandemic.[2]

Box 1: The dangers of import supply chain risk concentration: input cost escalation and loss of supplies

A large East African pharmaceutical manufacturer recounted that in November 2019 he made a routine order for bulk chloroquine from an Indian company. What followed exemplifies the financial squeeze from the input side. The price quoted and accepted was $32 per kilogram, and delivery was promised in February – a standard delay given the import logistics. At the end of January 2020, the recipient firm checked the order's progress in a routine manner, and was told 'No, we cannot commit to you now unless you pay $260 per kilogram'. In the face of this 800% price increase, the recipient firm cancelled the order. This is 'one real example of how African manufacturers were being treated', and of the final supply consequences for health services of reliance on a very small number of overseas suppliers of key raw materials including active pharmaceutical ingredients (APIs).

1 See for example reported views in Mackintosh, M., Mugwagwa, J., Banda, G. and Tunguhole, J. (2017).

2 See Chazan, G. (2020).

2.2 Constraints on using idle capacity

Many local manufacturers went into the crisis carrying spare capacity, which provided scope for their ability to respond to suddenly escalating local demand. As firms sought to use this capacity to expand production, crucial constraints included poor quality domestic supply options for inputs, substandard imported alternatives, and a lack of testing and regulatory capacity to allow local firms to bring new products rapidly on stream.

Manufacturers identified backward integration – by building up local production of high-quality inputs – as central to local manufacturing resilience. Examples given in the webinar of where backward integration was particularly important included:

- local production of some APIs to break the risk concentration on a few overseas, mainly Chinese, API suppliers (also a dependence of increasing concern in India);
- production of fabric suitable for a wide range of medical uses, closely linked to plastic manufacturing and processing sectors;
- production of better-quality health-relevant packaging, such as sterile plastic bottles and other plastic packaging for pharmaceuticals.

Manufacturers also identified the emergence of substandard new suppliers during the pandemic, with resultant rejection of outputs and financial loss, as a persistent challenge. One manufacturer argued that corrupt practices of kickbacks are typically more prevalent for import contracts than for locally sourced goods (given the lesser ease of shifting local currency payment abroad), which incentivises continuing national import reliance. More than one producer noted quality certificates, such as CE certification, could be and were being forged and were hard to check, indicating the need for greater local expertise, training and policing of standards.

The key term that recurs in these experiences is *quality*. All healthcare supplies need to be quality-assured, but when the Covid-19 crisis hit, the weakness of crucial testing capabilities across Africa quickly became a constraint for repurposing idle capacity. There was a need, one manufacturer argued, for 'backwards integration to build resilience all the way down the [supply] chain.' To do that, testing capability and accreditation are key.

Testing capability is not missing entirely, but it is over-specialised and needs a broader base. For example, a medical, sterile, clean room-produced face mask must be sent to the US or Europe for quality testing at a current cost of around $3,500. One manufacturer noted that there are many internationally recognised testing houses present in African countries, but they were not necessarily offering the needed services. Ghana, for example, has an internationally accredited testing facility to do all the testing for the mining industry but it has not expanded its facilities to test other items.

Other countries such as Zimbabwe also have metrology departments and in-house testing facilities for some enterprises that require flexibility and accreditation. Facilitating the ramping up of local testing, certification and accreditation, and their flexible repurposing, would in turn break blockages which obstruct the repurposing of spare manufacturing capacity during crises – and in more normal times.

2.3 Creative manufacturing responses: local facilitators

In the face of all these constraints, local manufacturers have nevertheless managed to respond creatively across many African countries. A key facilitator of these responses has, as a Southern African manufacturer observed, been the willingness of local producers to share technology and to increase production of critical products where equipment complementarities and technology transfer were possible. Public-private collaboration has also emerged, tackling what one manufacturer called 'prohibitive procurement regulations' and finding methods to facilitate innovation (Box 2).

Box 2: Cross-sectoral collaboration as key to rapid local response: sanitisers and test swabs

Two essential Covid-19 supplies were hand sanitisers for very widespread use and swabs for Covid-19 testing. A participant described a cross-sectoral collaboration between an East African medical research institute, other government regulatory bodies, and firms in several industrial sectors to meet local demand when imports were suddenly unavailable. The research institute already produced sanitisers in collaboration with a local manufacturer. When Covid-19 hit, all inputs went out of stock. Scaling up production required ethanol from local sugar producers to be applied to sanitiser production; a second pharmaceutical company was brought in to add capacity; and a local plastics firm scaled up bottle production and created a cap redesign to replace the unavailable pump delivery system previously imported from China.

A comparable collaboration between the medical research institute and a textile manufacturer previously producing ear buds adapted the manufacturing process to local production of swabs. The researchers worked with the firm at all stages to ensure the swabs met the required standards, including finding sources of nylon, testing the effectiveness of flock heads since brush heads could not be produced, and ensuring sterilisation. At the same time, the research institute scaled up its existing in-house production of viral transport medium (VTM) (previously made for research use) by repurposing an existing production line for bacterial culture media to produce VTM for transporting swabs to the laboratory.

Webinar participants noted an impressive list of products with which African manufacturers responded to Covid-19 requirements at speed, through scaling up and product innovation. It includes (but is not limited to): in pharmaceuticals – dexamethasone, paracetamol and azithromycin, all used in Covid-19 treatment and all widely available in generic formulations; sanitisers and decontaminants; masks, gloves, overshoes, face shields, medical scrubs, PPE of various quality including medical grade; ventilators designed and made from scratch; viral transport media and sterile swabs; individual and laboratory test kits; and clean room production facilities for medical clothing. Some of the innovation was strikingly fast, such as the production of Nigerian ventilators from design to build; and the development of rapid polymerase chain reaction (PCR) test turnaround, by 'people who weren't given the opportunity to innovate in a pre-Covid-19 world' (Southern African manufacturer).

3. Core lessons: key themes

The telling examples of manufacturing creativity described above relied centrally on what had gone before. Countries that were quick to repurpose were those that already had some hardware. African manufacturing associations had been working with governments for many years to promote the importance of local manufacturing for health in an era when much 'global health' policy appeared premised on the assumptions that medical health technologies were readily available commodities, that utilisation and access could be generated in a timely manner from global pharmaceutical value chains, and that 'global' advances in knowledge benefited all.

Long-term initiatives, including through the Pharmaceutical Manufacturing Plan for Africa,[3] had challenged this perspective.[4] Webinar participants noted that there has been a definite uptick in employment and value added in local manufacturing since the Plan was endorsed by Heads of States and governments in Accra in 2007.

From the very rich webinar debate on learning to date, we have pulled out some key themes, with the aim of reframing thinking on the importance, and facilitation, of local manufacturing for health in Africa. Figure 1 sets out these key themes and interconnections across the top two layers. We summarise them below under four headings and return in Section 5 to the policy implications developed in the third row of the figure.

3.1 Broadening and deepening the industrial base and reducing concentration risk through local suppliers, industrial collaborations and backward linkages

> *'When we talk about manufacturing for health we need to think [also] about allied sectors … the automotive sectors for reaching remote areas, the repackaging of containers, the cold chain and so on.'* (Indian engaged academic)

Industrial and supply capabilities relevant to the crisis were centrally rooted in 'hardware' such as existing manufacturing plant investment. Countries that were able to do most had a broader industrial base and a resultant capability to collaborate across industrial sectors to bring new products to market.

Evidence from Indian colleagues in the webinar suggested that there is a cumulative aspect to this industrial collaborative capability, since cross-sectoral collaborations occur when new products are successfully brought to the market. These experiences in turn generate co-learning opportunities for industrial improvement, such as between the packaging industries and pharmaceuticals when considering injectables or parenterals – as illustrated by a historical case of a Zimbabwean company collaborating with the plastics manufacturing industry in production of packaging.

Successful industrial development requires firms to have learned to compete effectively among themselves and externally, and also to collaborate locally in order to co-learn and co-solve both old and new problems to serve new markets. One lesson from industrial history is that this innovative capability is grounded in the generation of local knowledge over time. This is knowledge that needs recharging with new activity and which, if not constantly used, will face knowledge depreciation – as occurred in South African vaccine manufacture and Zimbabwe antiretroviral (ARV) manufacture.[5]

Industry associations can act as brokers or intermediary institutions to facilitate knowledge

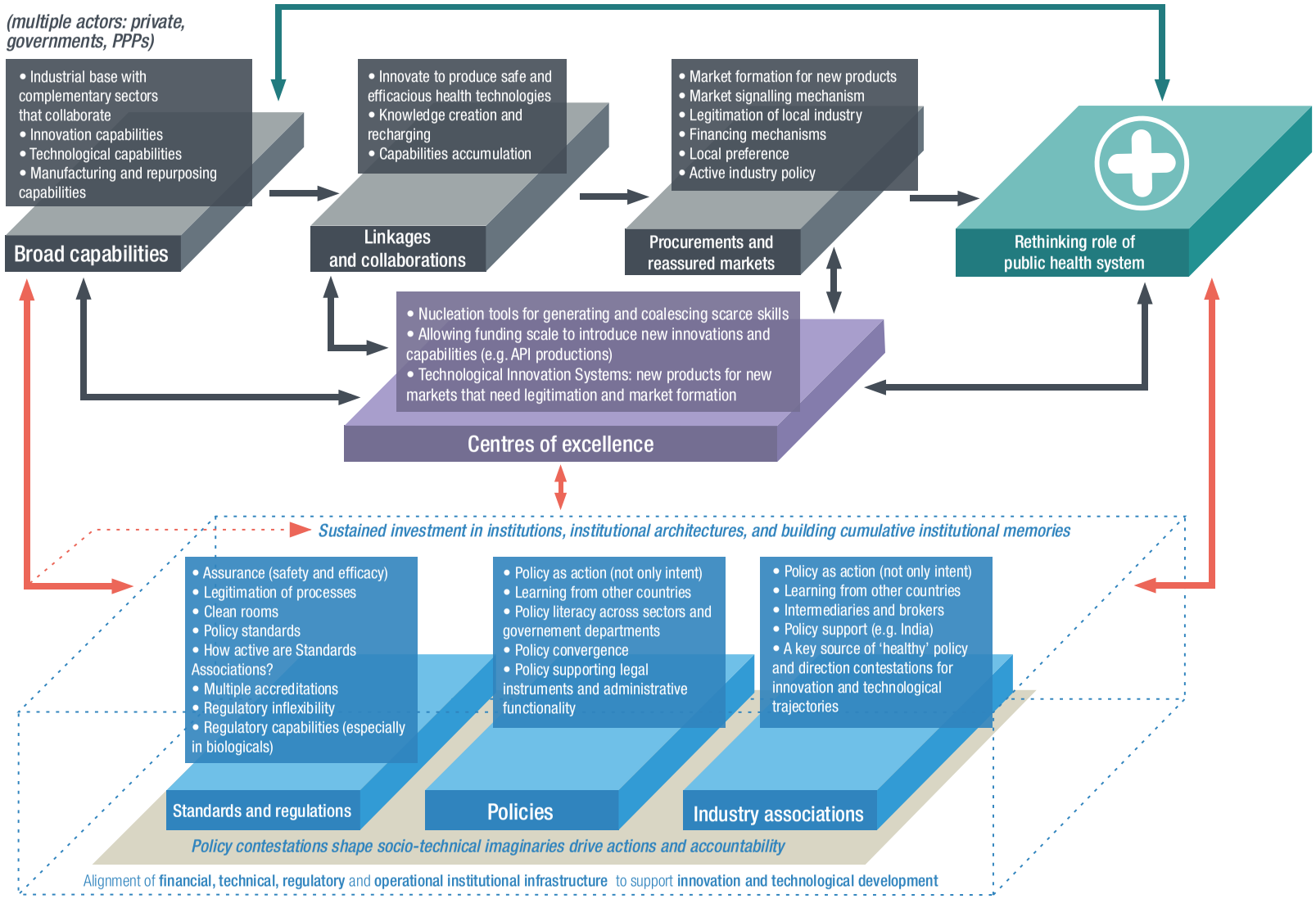
3 See African Union (2012).

4 See also the contributors to Mackintosh, M., Banda, G., Tibandebage, P. and Wamae, W. (eds) (2016a).

5 Personal communication between the authors and industry contacts indicate that while Zimbabwe was the first African country to locally manufacture generic ARVs in the early 2000s, they have fallen behind in the portfolio of latest ARVs on the market. Similarly, South Africa had institutions that focused on different types of vaccine manufacture, yet in the 1990s most of these were shut down, resulting in institutional memory loss.

Figure 1 Key themes and implications

- Manufacturing for health: allowing complementary industry development
- Health sector as a primary driver shaping local industry
- Health sector as a key component of the health-industry complex
- Health sector imbuing system resilience and agility that shortens supply chains
- Key player in localisation and industrial transformation agendas
- Plays a major role in value chain backward integration as a consumer of medical health



renewal and promote linkages between critical sectors, and can signal through policy debate where different sectors' interactions are increasingly important. For example, new tools such as artificial intelligence (AI) and machine learning will play a significant role in promoting efficiencies and with performing dangerous routines, as is characteristic of oncology drug manufacture where automation decreases the risk of exposure to toxic substances for workers.

Industry associations can also shape the direction for linkages and network formation. While the Indian experience suggests that building these links has been particularly challenging in the medical device and diagnostics fields, industry associations in India have responded to the pressures of Covid-19 by bringing together start-ups and smaller firms with larger manufacturers to produce ventilators and protective equipment. It can be a challenge for particular sub-sectors to preserve knowledge accumulation that is based on cross-sectoral collaboration, since some collaborations will be transactional and may not continue once a crisis has passed. Governments may need to find ways to support local cross-sectoral industrial clusters to sustain local learning and capabilities.

Webinar participants also recounted examples of the *concentration risk* exposed by the Covid-19 pandemic. Concentration risk implies reliance on one or a small number of suppliers, generating the risk of a sharp cut-off through loss of those suppliers, vulnerability to monopolistic input pricing and resultant financial loss (Box 1). In pharmaceuticals, a pointed example of concentration risk was identified in the webinar with reference to the global production of APIs. Indian pharmaceutical firms and the world as a whole depend heavily on API production in China. From a perspective of business and health systems risk and resilience, there is a need to mitigate the systemic risk generated by this concentration. An adverse event in China will feed on that risk, and ricochet around all pharmaceutical manufacturers. Hence, decentralising API and excipient manufacturing is recognised as a strategic move for health security: both African and Indian companies need to rethink the scope for local API and excipient production.

A Southern African manufacturer argued that there are now real technological opportunities in this field. Industry is shifting away from the 'cathedral model' of imposing, capital-intensive and large-scale plants towards a more modular approach to manufacturing and associated automation that generates opportunities to produce APIs and excipients locally at appropriate scales for local consumption.

There is a clear need to broaden the health industries' industrial base in Africa, including in medical devices and diagnostics. Perhaps the greatest technical challenge lies in development and manufacture of biologicals (including vaccines) as well as associated regulatory capabilities. The continent has only four vaccine manufacturers, in Egypt, Tunisia, Senegal and South Africa. The technologies they are using may need to be upgraded and they may also need to adopt emerging platform technologies such as those based on messenger ribonucleic acid (RNA) or recombinant protein. The South African government has set aside some funds to support scale-up of local vaccine manufacture. There may be room for South-South learning from India, which has made strides in biosimilars and vaccine manufacture.

3.2 Building collaborative capabilities engaging multiple actors: private sector, government, and public-private partnerships (PPPs)

> *'Medical devices and diagnostics … have been neglected in India … If you are going to grow the sector it will require testing facilities, access to funding, planning support, all of that.'*
> (Indian engaged academic)

In addition to 'hardware' and industrial cross-sectoral collaboration, countries that have been able to react fast have displayed capacity to *collaborate, co-learn* and *co-solve* old and new problems across industry, academia and government. The example of collaboration in Box 2, which brought in relevant government ministries to tackle an industrial collaboration challenge, leveraged production and innovation capabilities developed for public clinical research in order to scale up commercial production

for public health. This provides evidence that bringing together different industrial and government sectors is important for solving immediate production problems, as well as for longer term policy learning and influence.

Collaboration can leverage existing linkages and generate new collaborations to overcome inertia that accrues due to lack of trust between and among institutions and actors. There is good evidence that crises on the pandemic scale can help to generate innovative collaborations to support a response. The unsolved challenge, not well addressed in the webinar, is this: how do stakeholders (including industry, academia and government) generate and sustain the momentum required to purposefully establish linkages and collaborations outside of crisis-driven and serendipitous linkages?

Literature on learning[6] posits that the greatest opportunities for learning occur through interactions at disciplinary boundaries. Linkages and collaborations are therefore critical for the trans-disciplinary learning central to solving complex problems. How can we ensure this new learning is sustained?

The webinar explored and discussed existing facilitating mechanisms for local pharmaceutical production that had been built up in and across African countries pre-Covid-19. Transnational facilitation included the work of the African Union's Development Agency (AUDA) and the New Partnership for Africa's Development (NEPAD) on regulatory harmonisation, and the work of the Federation of African Pharmaceutical Manufacturers Associations (FAPMA).

National examples cited included pharmaceutical parks with infrastructure investment in Ethiopia to facilitate foreign direct investment, and a plan for a pharmaceutical park in Nigeria. Preference for local tendering has been brought in for a range of pharmaceuticals in Uganda, alongside regulatory efforts to create a level playing field for manufacturers with Indian exporters. Ethiopian incentives for investment in pharmaceuticals include advance payments for orders and tax-free loans and tax holidays for new investments. Tanzanian incentives noted included: reductions in corporation tax for the first five years for pharmaceutical manufacturing investors; price preferences in public procurement for local manufacturers; lower registration fees; and the waiving of Good Manufacturing Practice (GMP) inspection fees for local manufacturers.

3.3 Re-thinking the role of the public health system in industrial development: innovative procurement, assured markets and technology shaping

> *'In most countries … manufacturing decisions are in the Ministry of Industry or Trade … Ministries of Health tend to make procurement decisions ignoring the decisions their colleagues in Industry are making … Convergencies between these two tend to be very weak.'*
> (Southern African engaged academic)

The authors of this report have previously argued,[7] with many others, that building a strong industrial supplier sector to strengthen and secure local healthcare requires sharply rethinking the nature and role of public sectors in health systems in relation to those industrial suppliers. It is useful to think of the health sector as itself a major service industry that is generally in mixed public-private ownership; closely integrated into a health-industrial complex in which industrial development is strongly shaped by public and private health spending.[8]

This framework challenges a passive view of health systems as merely purchasers of items designed and produced elsewhere, recognising instead the iterative processes through which health technologies are developed and adopted. This framework also links up to a decolonisation agenda where the framework of the health-industry complex returns agency, power and leverage to the local health system – both in terms of shaping dialogue, and the trajectory that should be taken in solving local health challenges.

6 See for example Lajoie and Poitras (2017).

7 Mackintosh et al. (2016a, 2017).

8 Mackintosh, M., Tibandebage, P., Kungu, J.K., Njeru, M.K. and Israel, C. (2016b) .

The health sector has purchasing power, power of technology choice, and technology adoption options. It therefore shapes who supplies what technologies, and by so doing it shapes the health technologies supply terrain. Examples shared in the webinar and discussed above illustrate local moves away from procurement processes that focus only on immediate price and towards addressing cash flow and the competitive requirements of emerging industrial clusters.

Local industry has demonstrated during the Covid-19 crisis that local industrial capabilities and shorter supply chains really do produce a more agile response in medical emergencies. Local decisions on procurement, technology choice and adoption shape complementary sectors of local industry. The health sector is a large and important recipient of public funds; expenditure that governments can leverage as part of their industrial policy to support local industry beyond times of crisis.

From this perspective, a potent role for procurement as part of an active industrial policy lies in de-risking early stages of technology development and introduction by assuring markets. Advance purchase commitments by high-income country governments for the Covid-19 vaccines confirmed this crucial role, by assuring innovators to invest in vaccine development and manufacture.

Participants in the webinar repeatedly noted that assurance of market access was a – perhaps *the* – key determinant of willingness to invest. This implies that advance market commitments, if they are to advance African health security, should support market access by emerging African suppliers, rather than focusing only on established exporters.

Innovative procurement[9] can generate industrial innovation through assured markets by supporting the following:

- **Market formation for new products:** new-to-country products or new to the world.
- **Market signalling mechanisms:** assured markets to support entrepreneurs' risk taking and investment decisions and assist them in proposing attractive projects for financing to commercial funders.
- **Legitimation of local industry:** by underwriting early technology risk and procuring products, the public sector serves as a legitimation tool for the diffusion of new technologies and innovations.
- **Financing mechanisms**: in countries like Ethiopia and Uganda, advance payment and local procurement has helped entrepreneurs reduce their working capital funding requirements and avoid high interest charges from commercial banks.
- **Local preference:** as one of the ways innovative procurement can be deployed.

The recognition that health spending can effectively leverage complementary industrialisation alongside greater local health security, while reducing external aid dependence, creates an incentive for African governments to move towards the 15% of public sector budget to be spent on health, as agreed in the Abuja Declaration in 2001.

Two further arguments on market shaping and public health sectors came together in the webinar as participants identified the importance of regional harmonisation of regulatory rules and processes to support regional and cross-continental market integration. Two manufacturers noted that the Covid-19 emergency had brought out some local 'nationalistic' conflicts of interest, leading to blocks on intra-regional trade. Non-tariff barriers, in particular, were seen to be still bedevilling the regional market integration needed for large scale industrial investment.

However, an experienced African regulator noted that the crisis had focused minds on using the capabilities within the existing structures and guidelines: for example, existing continental guidelines for clinical trials and emergency preparedness are being used now for Covid-19 vaccines preparedness. In addition, using existing regulatory structures, African stakeholders have been able to establish a continental medical regulatory committee – the Africa Medical

9 For a further discussion of this concept, see Chataway, J., Banda, G., Cochrane, G. Manville C. (2016) in M. Mackintosh et al. (eds) op. cit.

Products Regulatory Forum. The Forum has enabled the production of guidance documents for Covid-19 diagnostic tests, medical advice and PPE, as well as guidelines which could be issued to domestic manufacturers and used to report substandard medical products throughout the continent. This response capability in turn reflects a decade of work in regulatory harmonisation through the Medicines Regulatory Harmonisation (MRH) initiative[10], and the work to incorporate the African MRH as a specialised arm of the African Medicines Agency (AMA), now moving slowly towards ratification.

3.4 Centres of excellence and infrastructure to support quality and technological capabilities

> *'Centres of excellence should work well in Africa: we have a lot of common issues, just needs political will.'* (East African manufacturer)

The discussion of regulation returns us to *quality* – a key aspect of industrial response. Manufacturers emphasised the lack of testing institutions (Section 2) when testing was needed locally and at speed for new products. This stimulated a broader discussion of the key role that could be played by centres of excellence to support industrialisation for health.

One engaged academic with extensive manufacturing experience argued that centres of excellence can tackle those problems that cannot be solved by emerging industrial clusters, because no firm can accumulate all the skills, resources and capabilities needed. Furthermore, there is an acknowledged lack of patient capital for supporting innovation and coping with the inherent failure rate accompanying innovation efforts. This can also be incorporated within a centre of excellence that can draw on in-house skills to support investment decisions.

This centre of excellence idea is not new on the African continent. One earlier example was the African Network for Drugs and Diagnostics Innovation (ANDI), an initiative that was not sustainably funded. ANDI set up Centres of Excellence in different countries which were intended to serve as 'nucleation' centres for generating knowledge, accumulating capabilities, and transferring the knowledge and capabilities to others through inter-organisational collaborations (the metaphor of 'nucleation' is borrowed from chemistry where a crystal is immersed in a concentrated solution to accelerate the crystallisation process). In this case, a centre of excellence can be a starting point – a seed crystal – for building and accumulating a range of complex technological, innovative and industrial capabilities, leading to scale.

The key issues that the centres of excellence are intended to address include: nucleation tools that generate and coalesce sets of scarce skills and capabilities; pulling together patient funding at scale that is sufficient for industrial step-changes (such as a move to API production); supporting product innovation for new markets to gain legitimation; and working on market formation and integration for entry of new products.

Centres of excellence can also interact with the demands from the health sector to force backward integration, for example into APIs. They can act as centres for knowledge development and diffusion for industrial sectors; they can support entrepreneurial experimentation and shape direction of technological search; and can foster collaborative interaction among industrial firms and other stakeholders.

Recent work by one academic webinar participant on regenerative medicine demonstrated that, for nascent industries where emerging entrepreneurs need to demonstrate proof of concept, innovation brokers play a pertinent role in de-risking the early stages of innovation, and these brokers could be centres of excellence. Stronger integration of centres of excellence that focus on health needs with countries' broader industrialisation strategies and with stronger commitments to health-industrial policy collaboration may help to sustain existing centres' effectiveness and generate new centres of excellence over time.

10 See Sillo et al. (2020) for a good discussion of the East African MRH.

4. Learning from Indian experience

Indian participants in the webinar stressed the scope for learning from both Indian strengths and weaknesses. The Indian pharmaceutical industry represents a highly successful case of a developing country that has built strong local manufacturing capabilities in pharmaceuticals and vaccines over the last 50 years. However, similar success has not been evident in the medical devices and diagnostics industries. Two strong themes – and a relevant industrial gap – emerged from the Indian experiences of response to Covid-19 and the capabilities underpinning them.

4.1 Broad-based manufacturing capabilities

> *'General manufacturing capabilities – issues of process in stocking, ports' availability, technical standards, turnaround times – these are wider than the health industry.'*
> (Indian engaged academic)

The first theme was strong support for the importance of broadly based manufacturing capabilities (Section 3) across diverse sectors, in order to develop local healthcare technology industries. The broad Indian industrial base contributes to sustained creation of local engineering knowledge, reliable supply chains and opportunities for diversification. For example, if an Indian firm wants to make injectable pharmaceuticals, one of the many plastics manufacturers will be invited in to work out how to do it.

New initiatives are generated from the latent capacity and synergy that exists in multiple industrial sectors. If there is a drop in demand in one sector, then there is scope for companies to move into other sectors. The benefit of these broad-based manufacturing capabilities was evident in the Indian response to Covid-19 when the Indian Space Research Organisation (ISRO) and automobile firms moved into ventilator production. A webinar participant noted a parallel experience in Nigeria, which has one of Africa's broadest industrial capabilities, where the military developed ventilators. Allied Indian industrial sectors, such as the automobile or electronic industries, are also critical to ensure delivery of medicines, vaccines, and diagnostics to remote areas, including delivery of pandemic requirements.

Also noted in Section 3 was another critical aspect of local manufacturing for health: creating linkages among these diverse sectors and setting up policies that contribute to developing the industrial ecosystem. This activity has, however, been severely lacking in Indian industry, clearly affecting the growth and development of the medical device and diagnostics industries.[11] The Indian government has imposed high import duties on some components such as glass screens that can be used in smartphones but also in medical devices. While the purpose of high import duties is to encourage local production, it is hurting the medical device and diagnostic industries. Local supplies are limited in scale, adding significant delay to production. The lack of this sort of ecosystem consideration in policy and an absence of sectoral collaborations and linkage are affecting the development of medical devices and diagnostics sectors in India. This raises the question of whether and how healthcare as a primary driver can shape industrial policy to grow other sectors.

Finally, manufacturing for health should also focus on local supply chains, and specific areas such as cold-chain mapping and delivery mechanisms. Webinar participants observed that most discussion in this area has focused primarily on economic and technical challenges associated with setting up local manufacturing plants, but prior to Covid-19 little attention was paid to cold-chain storage and delivery facilities in India.

11 Nabar and Brahmo (2017).

4.2 Contestation, policy literacy and problem-solving agility

> *'Civil society and scientific community engagement play a very important role in keeping policy-makers on their toes.'*
> (Indian engaged academic)

The second theme may be less familiar. Most studies of the development of technological capability in the Indian pharmaceutical and biotechnology industries credit government policies, such as the adoption of weak patent laws in 1970 which created a network of research laboratories, and the setting of public sector firms to produce pharmaceuticals locally. Public sector units and research institutes created the knowledge base that provided a foundation for the future development of the Indian pharmaceutical industry, while the Patents Act of 1970 protected local pharmaceutical firms and facilitated the building of India's reverse engineering skill sets.

However, what remains neglected in academic and policy discourse is the critical role of *contestation* in the creation of policy frameworks that supported the development of Indian local health industries. Contestations among various stakeholders – within what one webinar participant described as India's 'noisy democracy' – contributed to policy literacy, learning and problem-solving agility among Indian policy- and decision-makers. The politics of contestation is evident in the development of industrial policy and negotiations of relationships with the World Trade Organization (WTO) that have helped to build the sector. It was argued that the resulting policy literacy and learning provided scope for challenging discussions and serious engagement from a diverse set of stakeholders about how institutions should be built. Civil society organisations and networks (including science associations and industry associations) significantly contributed to the debate and to promoting Indian local production and collaborations.

For example, Indian healthcare technology industries are represented by associations that cater to various interest groups such as: small firms, overseas multinational corporations (MNCs) and local MNCs. They are represented by industry-specific associations such as the Indian Drug Manufacturers Association (IDMA), the Organisation of Pharmaceutical Producers of India (OPPI), the Association of Biotechnology Led Enterprises (ABLE) and the Indian Pharmaceutical Association (IPA), along with umbrella organisations such as the Confederation of Indian Industry (CII) and the Federation of Indian Chambers of Commerce and Industry (FICCI). The variety of industry associations plays an intermediary role and ensures that there is communication between small and medium firms, local MNCs and overseas firms, and represents their views with government. Though they do not drive policy, industry associations are increasingly relied upon to provide policy support and insights.

The industry and science associations, along with other civil society organisations, have intervened extensively in India. Their challenging views have shaped the science and technology (S&T) institutions and contributed to the development of the Indian pharmaceutical industry. Where policy convergence in India came about, it did so through the constituencies that got together, with political contestation playing a critical role in harmonisation. These noisy contestations significantly contributed to the policy literacy and development of consensus-building abilities among Indian policy-makers.

Such policy literacy is increasingly evident in decisions taken by the Indian government on critical policy issues. These include the signing of the WTO Trade-Related Aspects of Intellectual Property Rights (TRIPS) agreement; acting as the main investor for the setting up of the biotechnology industry; issuing compulsory licences; and, more recently, incentivising API production through policy initiatives. In terms of policy coordination, the office of Principal Scientific Advisor to government is leading the charge with the minister for S&T policy. Many specialist positions and empowered groups are being set up, but the connection between science policy and economic policy is still at a nascent stage.

4.3 South-South collaboration: a gap to be filled?

While there have been sporadic examples of India-Africa collaboration in the healthcare technology industries, they are on a minimal scale. India is a major pharmaceutical exporter to Africa but not an important pharmaceutical investor, though there have been a few investments. This history contrasts with the Indian industries' strategies in Latin America, where Indian pharmaceutical firms are setting up production facilities to cater to local markets.

For example, one participant pointed out that in 2020, six generic drug makers – Dr Reddy's Laboratories, Zydus Cadila, Glenmark Pharmaceuticals, Torrent Pharmaceuticals, Hetero Drugs and Ackerman Pharma – signed a deal with Hidalgo State in Mexico to set up a large pharmaceutical production and logistics cluster to cater for Latin American regional needs. The Mexican government has offered the Indian generic drug makers preferential status in the public procurement of medicines, in addition to making it easier to register drugs and to export them to other Latin American markets. This has resulted in about 21 Indian drug companies establishing business operations in Mexico.[12]

However, similar interest in setting production facilities in African regions seems to be lacking among Indian pharmaceutical manufacturers. One of the explanations provided by the manufacturers is that, like India, African markets are low value and high-volume, which reduces their attractiveness in terms of making greenfield investments.

It is increasingly evident that Indian companies are in search of a high-value growth markets business model that can distinguish them from the growing competition among generics firms. Yet, there is an acknowledgement among Indian stakeholders that there is further scope for collaboration on issues around intellectual property (IP), medical device and diagnostic industries. For example, India and South Africa jointly requested the WTO for temporary suspension of certain IP concerning diagnostics, vaccines and therapeutics related to Covid-19. This is an area where African market integration, demand shaping and policy shifts could change incentives towards more local production and technology transfer from India to Africa in the medium term.

12 See Sukumar (2020).

5. 'Staying awake': building for the longer term

> *'In many African countries, barriers to local manufacturing aren't necessarily restricted to pharma or health, they are broader barriers such as infrastructure … So we may want to frame our work in this broader context.'*
> (Engaged African academic)

There was broad agreement among African webinar participants that Covid-19 had been a wake-up call. The problem however, as one participant put it, is 'there have been so many wake-up calls. How are the people who have been woken up going to stay awake?'

The pervasive and immediate impact of Covid-19 was felt to have been a particular wake-up call for governments about the weaknesses of their health systems. One manufacturer argued that, for decades, African healthcare has been neglected, and then when top government officials fell ill, they would 'hop on a plane' to Europe or Singapore. When Covid-19 hit, they were no longer able to do that, with tragic consequences for some. This perceived 'national disgrace' (in the words of one African manufacturer) has created a new realisation of the need to invest in local health systems – including their supply chains.

5.1 Issues and options

An issue can be thought of as a vital concern or unsettled problem. In the context of local manufacturing for health, issues included capabilities in research and innovation, manufacturing, regulation, policy and governance, finance and sustainable markets. In particular, issues relating to policy and governance were integral to the overarching narrative emerging from our contributors. We sum this up as a need for accelerated short-term action, and well-coordinated long-term national ambition, if the aim for local manufacturing for health is to be practical, cost-effective and sustainable.

This summation opens up a range of policy options, all of which should broadly result in mitigation of the impacts of the pandemic, consolidating the capabilities ushered in by pre-pandemic and pandemic actions, and upscaling and embedding manufacturing capabilities within the broader national health and industrial structures. Mitigation, while discussed only tangentially in the webinar, applies to options and actions for avoiding further damage from the pandemic. Consolidation applies to options and actions in the further use and embedding of capabilities that have arisen from responses to the pandemic.

Contributors noted the importance of agility and adaptability, not just in manufacturing capabilities, but in policy and governance measures as well. Furthermore, mitigation, consolidation and upscaling options exist at different points in sectors connected to local pharmaceutical manufacturing, but the context for implementation and the potential to contribute to building sustainable local manufacturing differ between sectors and countries.

This section builds on the broad themes emerging from the African and Indian experiences to identify some options for African countries to emerge from the pandemic with stronger health-industry complexes. The bottom layer of blue boxes in Figure 1 lists key points and interactions in some detail.

5.2 Early priorities for medium-term support

Reflecting on lessons from successes and challenges to date, participants identified some practical collaborative problem-solving achievements that addressed the immediate needs of the crisis. Box 2 described one such collaborative effort involving government ministries and industrial sectors, plus researchers. A participant noted that in Ethiopia the government had offered tax relief to some existing firms to provide breathing space during the Covid-19 pandemic. Donors have supported immediate needs such as subsidised programmes to make medical scrubs in Ghana.

PRODUCTION FLOOR OF MAAGRACE GARMENT INDUSTRIES LIMITED (MGIL) FACTORY IN GHANA, 2020 IMAGE REPRODUCED WITH PERMISSION FROM ETHICAL APPAREL AFRICA. CREDIT: KEREN PYBUS.

Incentivised by the crisis, governments are also responding with longer-term thinking. For example, South Africa had been importing much of its paracetamol, manufactured in India by a South Africa-based company. As the crisis bit, the country was (like others) 'within five weeks of running out of paracetamol'. The Ministry of Health responded with a task force to look at localisation of supplies and market access for local producers.

Several key areas for a medium-term policy focus emerge from the manufacturers' concerns. One is the testing-regulation-accreditation process. While the need to improve regulation is a long-term concern, the pandemic has focused attention on local testing resources. It highlighted the need to invest heavily in the skills and autonomous institutions that can test products to international standards, without the need for transport to Europe or the US. This gap was noted by several manufacturers as posing a major hurdle for innovators in African countries – from textiles to engineering.

A second is finance: both targeted support for firms and sectors, as in the long-proposed pharmaceutical fund, and major funds for infrastructure investment. Two sets of comments from manufacturers illustrate their thinking. One is around the importance of targeting funds to specific firms that can innovate and scale up fast, rather than, as one put it, 'spray and pray' funding, or funding open to all comers.

On this point, one manufacturer remarked on the billions of dollars going upfront to companies to deliver vaccines with no guarantee of success: 'Wouldn't it have been nice if that model had been used in Africa, to say "Look, we need masks, let's bring some technology quickly and give lots of money to three or four companies in a region and say, please do the masks?"'.

The second set of comments on finance also relate to the extent to which funds can be found for this type of support within Africa. One African manufacturer focused on this issue. Within weeks of the pandemic starting, he noted, 'the African Development Bank and the African Development Bank and UNECA[13] had put together a 7.5 billion dollar fund to deal with Covid-19 – but where was it when we needed help to build the capacity?' He concluded that the money is there on the African continent, but 'our priorities have been wrong'.

13 United Nations Economic Commission for Africa.

It is our hope that the pervasive impact of the pandemic will lead to an alignment of funding priorities with the industrial development needs of African countries.

5.3 Sustained investment in institutional architectures towards building cumulative institutional memories

Institution-building for effective policy is an under-studied phenomenon – especially in the health industries in African contexts. We use the word 'institutions' in this case to refer to norms, ways of doing things or the way the 'game is played'.[14] Institution formation, that is the cumulative process of acquiring capabilities and institutional memory, and the ability to form and reformulate institutions to support technology development and innovation, has been studied more extensively by innovation scholars looking at, for example, the manufacturing sectors in the western hemisphere.

Three key institutions emerged in a particularly intriguing manner in the webinar:

1. The institutions of governance, through standards and regulations.
2. Policy as institutions of development action, resource allocation and directionality, with elements of political economy emphasised in positive political contestations.
3. The institution of brokers and intermediaries as exemplified by industry associations.

Standards and regulation were accepted as key governance tools. Participants observed that there are certain immutable areas such as technical specifications and safety, while areas such as administrative competencies can be gradually improved. Policy was noted as an area that needs more research and interrogation, particularly with regard to policy as action (not just as intent). This includes policy learning from other sectors and countries, as well as deconstructing the linkages between policies and their supporting legal instruments and administrative tools that drive execution. We suggest that the pandemic could be an opportunity for what some scholars have termed institutional entrepreneurship;[15] purposive actions by individuals and organisations to intentionally deviate from existing structures and processes.

The momentum for local production witnessed in response to the Covid-19 pandemic represents an opportunity for a systematic structural transformation to higher productivity, higher knowledge and higher-skill pharmaceutical sector activities for African countries and other low-income economies. We see this as a key moment to move from responsive or emergency-induced manufacturing to sustainable and adaptive local manufacturing for local health.

Through a carefully crafted and implemented capabilities escalator which links research, manufacturing, regulation, financing and market capabilities, with policy and financing as overarching themes, there is possibility for transformative and integrative local manufacturing for health in Africa.

As highlighted in earlier sections, the extent to which sub-Saharan African countries can effectively harness and apply historical and current momentum towards sustained manufacturing capabilities depends on the nature and effectiveness of governance norms and the instruments and structures that they establish. This means aligning the design and connection between policies and legal frameworks governing local pharmaceutical manufacturing with national goals of health security and sovereignty.

One webinar contributor noted the difference between 'capital P' written policies, and 'small p' policy actions to support local production. An African regulator commented that 'Africa isn't short of policies at national, regional and continental level' to advance innovation, local production or the regulation of medical products. An African manufacturer commented that policies that 'sound good' may lack the legal

14 Nelson and Sampat (2001).

15 Garud, R., Hardy, C. and Maguire, S. (2007).

instruments for implementation – or policies or political directives may even contradict the legal mandate of implementing institutions – so that officials lack protection and may comply or be fired.

Building solid institutional capabilities is therefore a long-term process. While national legislators are, as a participant noted, key to this process, a regulator commented that in her experience, there are important mutual interactions between regional and national action. Where there are capacity limitations at a national level, regional integration can play a critical role to assist in building national capacity. As an African regulator remarked: 'Once you harmonise those [regional] standards you provide a platform where countries with less capacity can come through the regional platform to learn and build their [national] capacity.'

Others identified supports for building capacity, including 'robust advocates' from civil society to enhance accountability in terms of implementation of policies over time. Developing a common language and understanding among the variety of stakeholders was also identified as key. Ethiopia was cited as an example of a long-term concerted effort to effectively link national strategies to manufacturing plans and regulatory institutions, creating a common language and position from which to advance practical policy action.

Covid-19 responses have generated a good deal of potential for future action in the form of resources, structures and expertise. Coordination has emerged as an increasing problem, however, since stakeholders have different priorities and competing interests. An example has been clinical trials and production of Covid-19 vaccines for Africa: the Africa Centre for Disease Control has brought together key stakeholders, but coordination remains problematic. Similarly, there are many bodies doing procurement, some overlapping. Learning lessons for future coordination and institution building will be both difficult and important.

The analysis above highlights the importance of engaging with policy-makers if appropriate governance regimes – particularly policies, regulation and legislation, are to ensure sustainable, transformative and integrative manufacturing capabilities in Africa. Research support that generates an active push for different stakeholders to work together might help support that long-term goal.

6. Conclusions and areas for future research

This report has analysed and attempted to synthesise highly insightful discussions, rooted in African and Indian experiences, which took place in a webinar on local manufacturing for health in the time of Covid-19. In line with earlier arguments by many of the participants, these discussions highlighted the importance of local industrial and institutional capabilities in ensuring local (and hence global) health security.

The pandemic has not only exacerbated health and socioeconomic inequalities, weakened national health systems, and significantly slowed down economic growth attained by sub-Saharan Africa in the past two decades or so. It has also exposed a tough road to recovery ahead for the countries in the context of depleted capabilities. The distinctive local concerns from Covid-19 should be a loud call to 'wake up and stay awake' for countries (especially low- and middle-income countriesto pull closer together to implement policies for industry, financing, science and health in order to strengthen the security of essential supplies for local healthcare.

The rapid and impactful responses witnessed in some African countries have generated, as one participant noted, some 'superb products', which were created by people who had not had a chance to do so in the pre-Covid-19 world. How are these opportunities to be sustained through better priorities – a point many participants made – in the application of resources, structures, linkages, political will and expertise?

A key message is that sustaining this momentum requires building institutional mechanisms that ensure consolidation and coordination of broad-based industrial and regulatory capabilities and local agency, and also generate the contestation that holds these processes to account. Covid-19 has demonstrated forcefully that local manufacturing capabilities are critical for public health security, with particular reference to the health needs of sub-Saharan Africa. Learning from the pandemic experience, sustaining local opportunities for innovation and building a broad manufacturing base, while sustaining multi-sectoral collaborations, are all central items in that agenda.

The webinar discussions also highlighted several areas for future research. Here, to stimulate further thoughts and work, are some aspects of that research agenda and questions that need more unravelling.

- How can policy as action be re-imagined, taking a holistic and pragmatic approach to conceptualise all the soft and hard infrastructures required to support the development of medium- and long-term local health-industrial complexes, in order to support local health security and in turn global health security?
- Who are the stakeholders required to ensure the active policy contestation that continuously shapes local health security based on local industrial capabilities?
- What new innovative procurement policies are required to use public health spending as active industrial policy for supporting the growth of a broad industrial base that supports health?
- How can agility and adaptability be built into local health-industry complexes to prepare for future medical emergencies?
- How can regulation and governance be made fit for purpose for emerging sectors and for pandemic situations?
- How can the pharmaceutical sector diversify the concentration risk in the supply of key raw materials and attendant logistics challenges when countries lock-down?
- How can industry associations garner more clout and impact in raising key technological and innovation challenges that need to be addressed?

This is a critical research agenda. Despite much effort, health and manufacturing research for policy is still siloed into separate spheres of thought, research design, publication, impact

processes and policy debate. Can Covid-19 finally act as the catalyst to break through those barriers and pull together research on mutually supportive routes to integration of industrial, institutional and health policies for managing public health security risks in African countries?

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Appendix: Partial list of participants

The table below lists those participants in the webinar *Local manufacturing for health in the time of Covid-19* on 28 October 2020 who agreed to include their names in this report.

Name	Position, organisation
Mr Dinesh Abrol	Professor, Institute for Studies in Industrial Development, India
Mr Harvinder Alag	Director, Shagun International Pharmaceutical and Educational Consultants Ltd., Tanzania
Mr Aaron Bailey-Athias	Senior Communications Officer, ODI and Development and Economic Growth Research Programme (DEGRP), UK
Dr Geoffrey Banda	Lecturer in Global Food Security and Innovation, and Deputy Director – The Innogen Institute, University of Edinburgh, UK
Prof. Joseph Fortunak	Professor of Chemistry, Howard University, US
Dr Dinar Kale	Senior Lecturer in Innovation and Development, Open University, UK
Ms Julia Kraetke	Manufacturing Africa Adviser for Ethiopia and Rwanda, UK Foreign, Commonwealth and Development Office (FCDO), Ethiopia
Ms Grace Kramer	Manufacturing Africa Adviser, UK Foreign, Commonwealth and Development Office (FCDO), Nigeria
Prof. Maureen Mackintosh	Professor of Economics, Open University, UK
Mr Dominic McVey	Non-Executive Director, ODI and Ethical Apparel Africa, UK
Mr Nazeem Mohamed	Head of Pharmaceutical Sector, Industrial Promotion Services (IPS), Aga Khan Foundation, Uganda
Prof. John Mugabe	Professor at the Graduate School of Technology Management and Research Associate at the Institute for Technological Innovation (ITI), University of Pretoria, South Africa
Dr Julius Mugwagwa	Associate Professor in Innovation and Development, University College London, UK
Mr Emmanuel Mujuru	Chair of Board, Federation of African Pharmaceutical Manufacturers Associations (FAPMA), Zimbabwe
Mr Janak Nabar	CEO, Centre for Technology, Innovation and Economic Research (CTIER), India
Dr Skhumbuzo Ngozwana	President and CEO, Kiara Health, South Africa
Ms Onyeka Onwuegbunam Vivian	African Graduate Scholar 2019, University College London, Nigeria
Ms Keren Pybus	Founder and CEO, Ethical Apparel Africa, UK
Ms Louise Shaxson	Director of Programme, ODI and Development and Economic Growth Research Programme (DEGRP), UK
Prof. Smita Srinivas	Professorial Research Fellow in Economics and Development, Open University, UK
Ms Cecilia Wanjala	Commercial Manager, Production Unit, Kenya Medical Research Institute (KEMRI), Nairobi, Kenya

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